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A WIMSHURST INFLUENCE MACHINE.

E. H. Williamson, Jr.

Almost the first piece of apparatus which the amateur in electrical experiments wishes to construct is a machine to generate statical electricity. It used to be called "frictional" electricity, and the term was no misnomer. I distinctly remember how my arm used to ache while grinding away at the first machine I constructed, with the amalgamated cushion screwed tightly against the old wine bottle which served as a cylinder. But such a primitive instrument soon ceased to satisfy my ambitions, and, after numerous experiments and failures, I at last succeeded in making a Wimshurst Influence machine which, although crude in appearance, worked well and seldom refused to generate even in the dampest weather. It was built with such tools as are usually to be found in the amateur workroom, and without using a turning lathe. This invaluable accessory to the workroom I did not then possess, and it can be dispensed with in constructing this electrical machine, although it would simplify the making of some of the parts considerably.

The tools that are absolutely necessary are as follows: a cross-cut saw, compass saw, hack saw for cutting metal, breast drill to hold drills up to $\frac{1}{4}''$, $\frac{1}{4}''$ and $\frac{1}{2}''$ twist drills, square screwdriver, large rough file for wood, small flat file, small vise, a bit brace and one each $\frac{3}{4}''$, $\frac{1}{2}''$, $\frac{3}{8}''$ bits, wire pliers and pincers, shears for cutting thin sheet metal, soldering iron, solder and flux. The directions given here below are for a machine with plates 15″ in diameter as, in my opinion, there is no economy in smaller sizes.

I will endeavor to give the reader full detail for each portion of the work, thus avoiding the difficulties which I had to overcome by experiments. In the first place, hunt up an old cardboard box, such as the tailors use for sending home suits, selecting one with a heavy lid and bottom and at least 15″ across. Take a pair of pencil dividers and lay out a circle 15″ in diameter on each piece of card, marking the center plainly with a pencil or pen for future reference. Cut out the two circles, following the pencil lines carefully, and, armed with a tube of photo-paste, carry them to the nearest paint and glass store. Select two sheets of

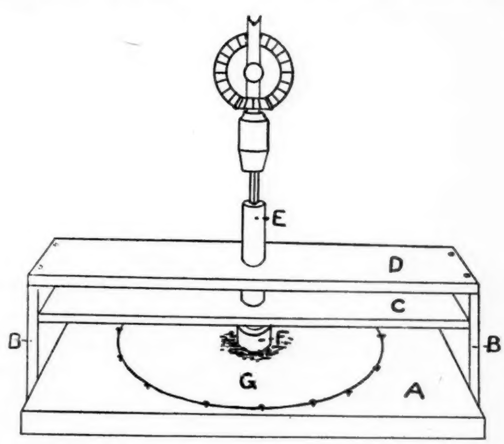


Fig. 1.

clear window glass, lay them on the counter and paste on the cardboard circles, one on each glass. The glass should be of such size as to leave an inch margin at least, around the card pattern. Now get the glazier to cut smoothly around the card with his diamond, and break away the surplus glass. This makes a better job than trying to do it yourself with a steel wheel glass cutter.

Having carried home the plates, we will prepare for the hardest part of the work, that is, cutting the holes in the center of the plates. The best method to accomplish this is that suggested by Mr. George Hopkins in his book "Experimental Science." (Fig. 1.) Set a piece of ¾″ board 18″ square, also two pieces 4″ wide and 6″ high, B 13. These are nailed to the ends of A. Two pieces 4″ wide, one 16″ long, C, and one 18″ long, D, are nailed across from B^1 to B^2, as shown in the figure. In the center of D, bore a perpendicular hole ¾″ diameter, straight down through D and C, but not into A. The board C should be fixed 2″ above A. Buy a piece, F, of copper pipe ¾″ diameter and 1′ long. File both ends square. Select a broomstick ¾″ thick and from this cut a piece, E, 7″ long and cut away one end until it can be forced firmly and square into the end of the copper pipe for half an inch.

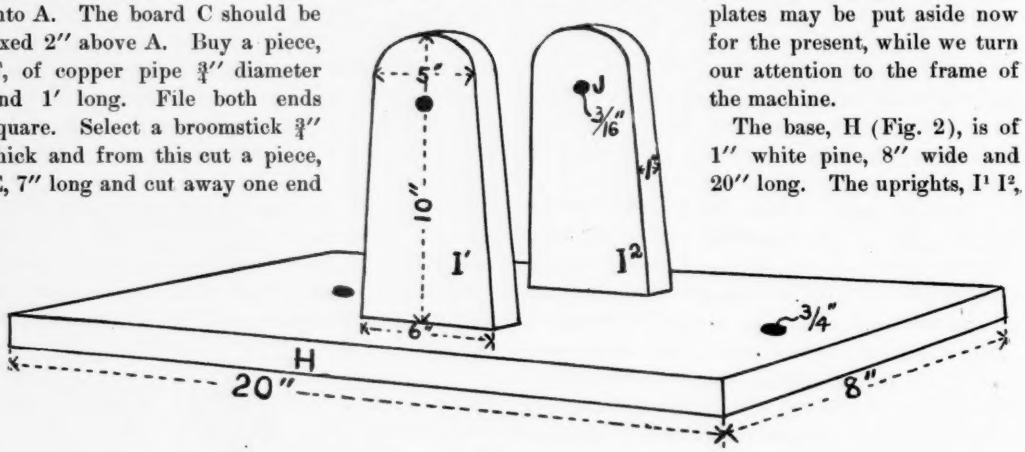


Fig. 2.

This is the drill for the glass, and the best method of revolving it is to put a dull bit in your breast drill and start boring a hole in the center of the upper end of the broomstick standard E. If a breast drill is not available, a bit stock will answer, but much care must be used. Detach one of your cardboard discs from the glass plate and with your compasses strike a ¾″ circle, using the old center. Lift the copper tube F, and slide the cardboard on to A, until the tube rests exactly on the small penciled circle, and fasten the card in that position. Now lay your glass circle upon the card so that the edges coincide exactly, and fasten the glass immovably with small screws at the edge. Get some fine emery powder (No. 80) and turpentine, and having wet glass and tube with the latter, scatter some emery on the glass under the drill, and commence turning the breast drill slowly. Do not press too hard, but let the drill cut slowly and steadily. Renew the turpentine and emery frequently, and, with care, the plate can be perforated in about twenty-five minutes, leaving a smooth round hole a little over ¾″ across. Just before the drill breaks through is the critical moment, and exceptional care must be used at this time.

Cut the second glass the same way, and when both are bored take a small file, and having wet it well with turpentine, cut a little niche on opposite sides of each hole, working very gently. The plates may be put aside now for the present, while we turn our attention to the frame of the machine.

The base, H (Fig. 2), is of 1″ white pine, 8″ wide and 20″ long. The uprights, I^1 I^2, are of 1″ pine, 10″ high and 6″ wide at the bottom, cut as shown, with sloping sides and a rounded top. The lower ends of these standards are to be cut perfectly square and are screwed firmly to the base, H, in a central position as to the length of the base, and 5″ apart from between the inside faces. A $\frac{3}{16}$″ hole, J, is bored in each, 8½″ from the bottom of each standard. When the latter are screwed in place, the holes should be exactly in line. At each end of the base, H, a ¾″ hole is bored in the center, 1″ from the end.

Before assembling the frame finally, it is well to put the wood into a moderately hot oven for half an hour and thoroughly bake it. After doing so, while the wood is still hot, coat it all over with white shellac. Let this coat dry thoroughly, and then give it another. This portion of the frame may now be laid aside for the present, and the mounting of the glass plates considered. Procure two large spools, such as patent thread is sold

upon, and some cigar-box wood, which should be a little thicker than the glass of the plates. Also get a piece of thin sheet brass, about No. 26 stubbs gauge, 10″ x 4″, a piece of $\frac{1}{4}$″ steel rod, smooth and round, 9″ long, and 10′ of No. 10 brass wire. At a store where they sell iron bedsteads get 9 of the $\frac{1}{2}$″ and one of $\frac{3}{4}$″ round brass balls such as are used to ornament the bedsteads. From an electric supply house get two pieces of hard rubber tubing $\frac{3}{4}$″ outside diameter and $9\frac{1}{2}$″ long.

We will now proceed to mount the glass plates. Take your $\frac{1}{4}$″ round steel rod, K (Fig. 3), and having clamped it firmly in a vise, cut from your sheet brass two pieces $2\frac{1}{2}$″ long and $\frac{7}{8}$″ wide, and bend them around the rod K, into two tubes, L, $2\frac{1}{2}$″ long

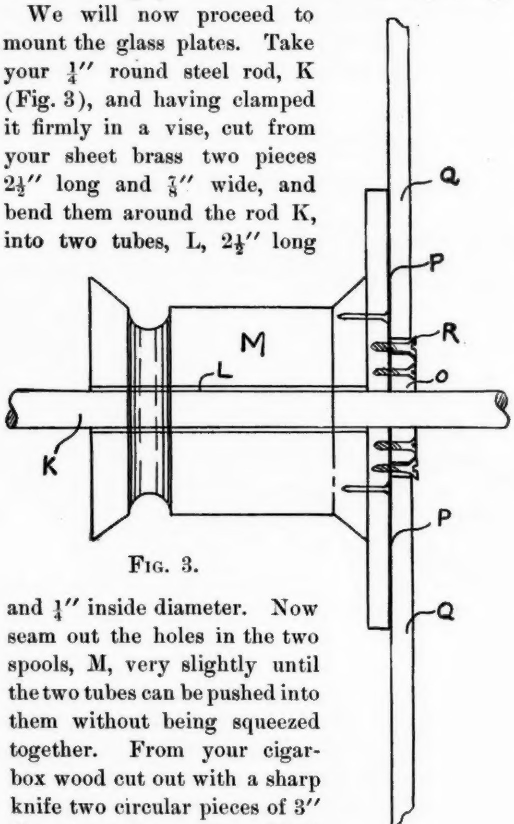


FIG. 3.

and $\frac{1}{4}$″ inside diameter. Now seam out the holes in the two spools, M, very slightly until the two tubes can be pushed into them without being squeezed together. From your cigar-box wood cut out with a sharp knife two circular pieces of 3″ diameter and two of $\frac{3}{4}$″. Mark the centers, and bore a $\frac{1}{4}$″ round hole in the exact center of each. Take one of the spools and nail one of the 3″ pieces, N, on one end, so that the hole in N corresponds exactly to that in M. The $\frac{3}{4}$″ piece, O, is then fastened to the face of N, observing the same precautions to get the hole in O opposite that in N. This is very important, as any eccentricity in O will make the plate turn unevenly. Glue a ring of paper, P, on the face of N, and slipping the glass plate into place so that it rests against N with the circle O projecting through the hole in the glass, take two very small screws, R, and screw them into N through the notches in the plate mentioned earlier. These will prevent the plate from turning.

To test the mounting for accuracy, slip the spool and plate over the rod K, for an axis, and spin the former gently round. It should turn easily, but not be loose enough to rattle, and the glass must revolve smoothly and evenly without wobble or eccentricity. If any such defects appear, the plate should be loosened from the spool and adjusted by shifting until it runs truly. When this position is found and marked, remove the plate, and coat both paper ring and plate with Van Stan's cement, and replace the glass, pressing the cemented surfaces together and putting in the screws again to hold all firm. The use of the paper is to allow the thorough adherence of the glass to the wood, the paper acting as a connecting link between the two. The other plate having been mounted in a similar manner, both should be laid away until the cement sets, which will take a couple of days.

We will now take up the making of the collecting combs and dischargers, shown in Fig. 4, in perspective. Take the hard rubber tubes, S, and fit to them two round plugs, T, $\frac{3}{4}$″ long and thick enough to fit tightly into the tubes. Through the center of these plugs bore $\frac{3}{16}$″ holes and drive a $\frac{1}{4}$″ machine screw $1\frac{1}{4}$″ long through the holes, so that $\frac{1}{2}$″ of thread projects from the end of the plugs. Cut from the No. 10 brass wire two pieces of $9\frac{1}{2}$″ long and bend them as shown in U, with a partly closed ring at the center, $\frac{1}{4}$″ inside diameter, and then out in opposite directions at an angle of 45 degrees for 1″, then straight again for $3\frac{1}{4}$″. The bends should be made symmetrically, so that the $3\frac{1}{4}$″ arms are parallel and 2″ apart. The four ends of these arms are scraped bright with a file, and wet with soldering fluid, and four of the $\frac{1}{2}$″ brass balls are soldered on the ends by the following method: Heat the ball for a few moments, place in a vise and pour melted solder in the hole until the ball is full. While the solder is liquid, insert the end of one of the arms for $\frac{1}{4}$″ and hold until the solder sets. Smooth all roughness from the joint with a fine file and emery paper. The combs, V, are made from strips of brass 3″ long, 1″ wide, with saw teeth $\frac{1}{4}$″ deep cut in the edges, as shown. The

strips are folded lengthwise over the $\frac{3}{4}''$ arms, so that the teeth of the two sets face each other, and are soldered to the arms.

For the arms, W, two pieces 6″ long are cut from the No. 10 wire. One end is bent in a ring $\frac{1}{4}''$ inside diameter, and the joint of the ring is closed with solder and smoothed. In constructing the machine throughout, care must be taken to avoid sharp edges and corners, to prevent the escape of electricity, excepting of course the teeth of the combs. The other end of the arm, W, is turned up for $\frac{1}{4}''$ and holds a $\frac{1}{2}''$ ball, X, soldered to it, as before described. In the top of the ball

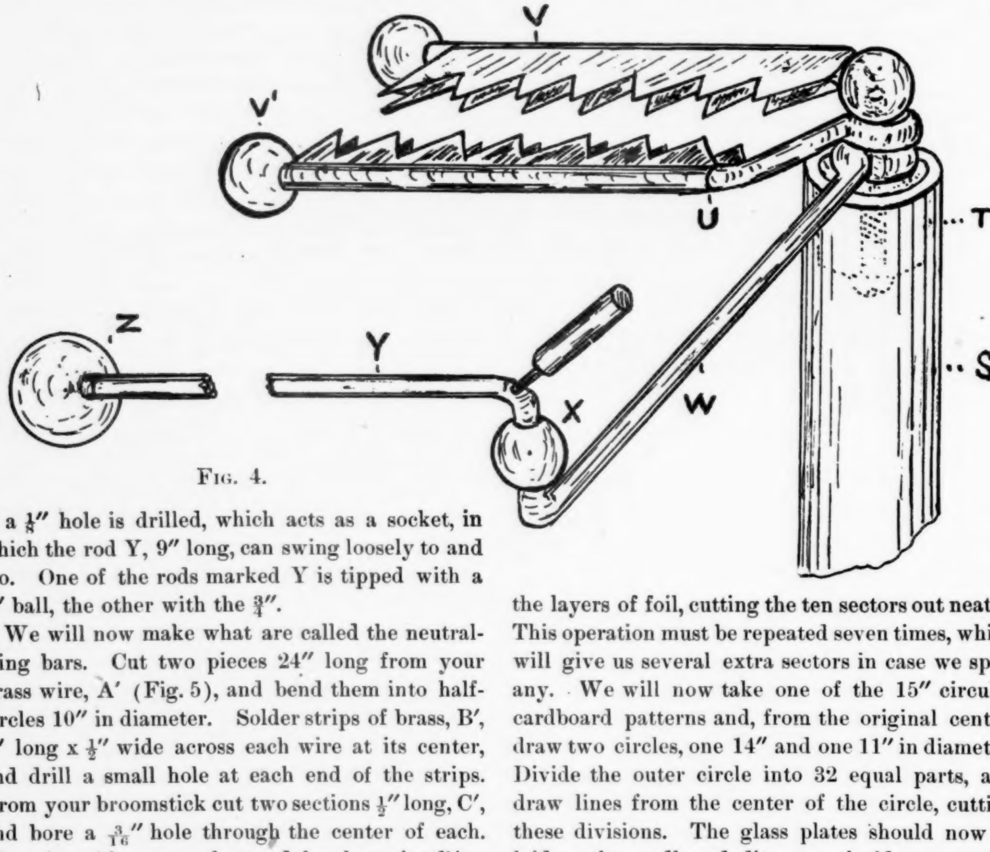


FIG. 4.

X a $\frac{1}{8}''$ hole is drilled, which acts as a socket, in which the rod Y, 9″ long, can swing loosely to and fro. One of the rods marked Y is tipped with a $\frac{1}{2}''$ ball, the other with the $\frac{3}{4}''$.

We will now make what are called the neutralizing bars. Cut two pieces 24″ long from your brass wire, A′ (Fig. 5), and bend them into half-circles 10″ in diameter. Solder strips of brass, B′, 1″ long x $\frac{1}{2}''$ wide across each wire at its center, and drill a small hole at each end of the strips. From your broomstick cut two sections $\frac{1}{2}''$ long, C′, and bore a $\frac{3}{16}''$ hole through the center of each. The wires A′ are now fastened by the strips B′ to the end of the wooden blocks C′, as shown in Fig. 5.

Our next job is to make 64 sectors of tin foil to be placed on the glass plates. Fig. 6 gives the size and shape sector required. The best way to cut these sectors is to make a die stamp of sheet tin 1″ wide nailed to a piece of wood corresponding to the outline of Fig. 6. The ends of the tin should be soldered and the cutting edge filed away until fairly sharp. A block of wood 3″ x 4″, sawed square across the grain, is used for a cutting board. Buy seven or eight sheets of heavy tin foil (it comes about 6″ x 8″) and fold it into a package $3\frac{1}{2}''$ long x $1\frac{1}{4}''$ wide, having ten layers of foil in it. Lay this package on top of the cutting block and place the die stamp, sharp edge down, on it, leaving a margin all around. If a flat piece of wood is now laid on top of the stamp and struck gently with a hammer, the stamp will drive through the layers of foil, cutting the ten sectors out neatly. This operation must be repeated seven times, which will give us several extra sectors in case we spoil any. We will now take one of the 15″ circular cardboard patterns and, from the original center, draw two circles, one 14″ and one 11″ in diameter. Divide the outer circle into 32 equal parts, and draw lines from the center of the circle, cutting these divisions. The glass plates should now be laid on the cardboard discs, spool side up, so that the edge of plate and edge of card coincide. The lines on the card will show plainly through the glass and are used as guides for attaching the tin-foil sectors. These are wet on one side with shellac, and attached to the upper side of the glass, upon the space between the 14″ and 11″ circles,

with the center of each sector over one of the 32 radial lines.

We will now take up the method of revolving the two plates in opposite directions. Purchase two cast-iron screw wall pulleys 4″ diameter and remove the grooved wheels by knocking out the pins. Get a piece of iron rod 12″ long which will fit tightly into the holes in the wheels. Bend the rod in the middle at right angles for 3″ and then straight again for 3″, making a crank. Take a piece of pine 5″ wide and 10″ long and 1″ thick, D′ (Fig. 7), and screw it to the bottom of the base

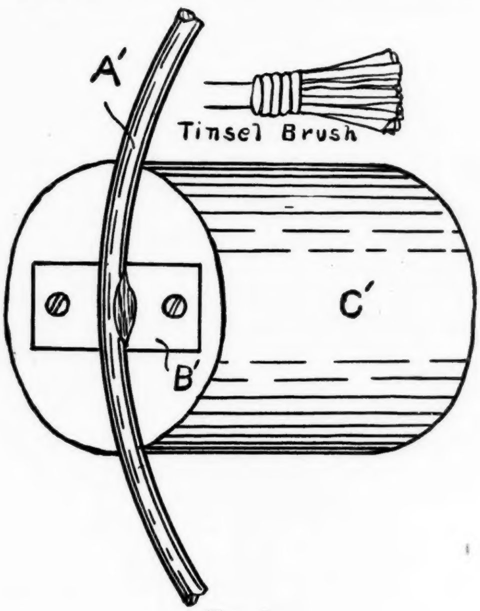


Fig. 5.

H, allowing it to project 6″ beyond the end of the base. Two upright supports, E′ (Fig. 7), 3″ wide, 5″ high and ½″ thick are now screwed to the sides of D′ at the far end, and ¼″ round notches are cut in the center of the top edges to hold the axle of the pulleys. The pulleys are now driven on the iron rod, the first two within 1″ of the crank and the second 1″ from the other end with 4″ between them. A 3″ piece of broomstick is now bored and forced on the crank for a handle. The whole thing can then be placed in the notches provided, and held in place with small strips of wood, previously notched, screwed over them.

Having revolved the pulleys with the crank and found that they turn truly and easily, we will remove them from the standards and put them aside while we assemble the machine. Take the base H (Fig. 7) and screw the rear standard I firmly in its place. The steel axle K (Fig. 3) is now slipped into the hole in I, and the two glass plates and spools are slipped onto the rod K, with enough cardboard washes between them to separate them $\frac{3}{16}$″. The plates are set face to face with the spools outward. Support the loose end of K and guide it into the hole in the front standard I′, which is then moved into position and screwed in place. The ends of K should project 1″ beyond the outside faces of the two standards.

The two neutralizing bars must now be tipped at each end with a small metallic brush. This can be made of either tinsel from a card of pearl buttons, or of very thin sheet copper. The tinsel or copper is cut into strips $\frac{1}{16}$″ wide and 1½″ long, about 15 being needed for each brush. They are hunched together and ½″ of the length is fastened to the ends of the bars by whipping them with fine wire. The bars having been thus prepared, the wooden block C′, to which they are attached, is thrust onto the end of K until the tinsel brushes just touch the tin-foil sectors on the plates. They

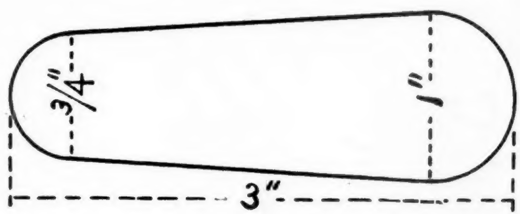


Fig. 6.

should touch the middle of the sectors, and any adjustments should be made by bending the wire arms. The lighter they touch the sectors, the better, so long as they are in contact during the entire revolution of the plates.

The blocks C′ should be turned on the axle K until the bars lie at an angle of 45 degrees from the perpendicular and 90 degrees with each other. The front bar should slant from right to left and the rear bar vice versa. The hand rubber rods S (Fig. 4) are now set in the holes at each end of the base, H, being forced to the bottom and glued. When these are dry, insert the two plugs T (Fig. 4) in the tips of the tubes, allowing the end of the machine screw to project ½″. Slide the combs U,

Fig. 4, into place, so that they embrace the sides of the glass plates, and slip the rings of U over the projecting ends of the screws. The rings in the ends of the arms, W, are set on top of those of the combs, and one of the brass balls is screwed down on both, clamping all firmly.

A convenient method of swinging the arm Y is shown in Fig. 7. A small hole is drilled at the bend of Y, and a copper wire having a short cylinder of wood attached, is inserted in this hole and soldered. One handle is sufficient. In order to take the strain off the arms, W, they may rest on a length of $\frac{1}{2}''$ glass tube, as shown in (8) stick the point of a large double-pointed tack through the holes, and bend the points together with a pair of pliers. The belts may now be sprung back onto the grooved pulleys, and should then be fairly tight, but not so much as to spring the shaft K. As the belts must remain parallel to the plates while running, it is desirable to cut round grooves in the spools with a half-round file to keep the belts from wandering from the center. The machine itself is now completed, but as in experimenting it is much more satisfactory to have condensers, I will describe a simple method of making them.

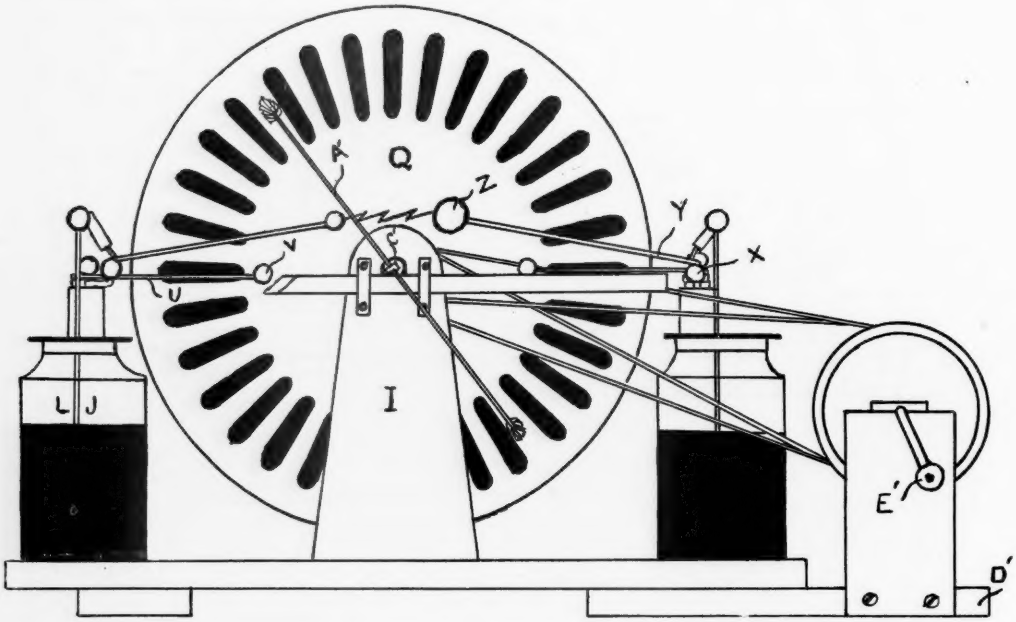


FIG. 7.

Fig. 7, the tube being clamped to the face of the standard, I, with a strip of brass.

The only thing that now remains to be done to complete the machine is to connect the spools and pulleys by belts. Get two pieces of $\frac{1}{4}''$ round sewing-machine belt 32″ long each. String the belt around the spools and in the grooves of the pulleys, and draw the ends of each belt together until within an inch of each other, having the rear belt crossed. Punch a little hole $\frac{1}{4}''$ from the two ends of each belt, and, having thrown them off the grooved pulleys, put the ends together and

Get two wide-mouth pint jars, such as candy dealers use for storing stick candy. They should be of white glass and fairly thick. These jars should be washed clean and then shellacked all over and covered with tin-foil inside and outside, including the bottoms, up to $\frac{2}{3}$ of their height. Two flat, thick corks to fit the mouths of the jars are now procured, and two circular pieces of cigar-box wood, a little larger than the mouths of the jars, are cut out. The wooden circles are glued to the tops of the corks, and both are shellacked.

(Continued on page 147.)

3-4 H. P. GASOLINE ENGINE.

C. E. Spaulding.

It is the object of this article to furnish the reader with a design and description of a gasoline engine for light stationary use, in as few and plain words as possible, in order that every part of the work may be thoroughly understood.

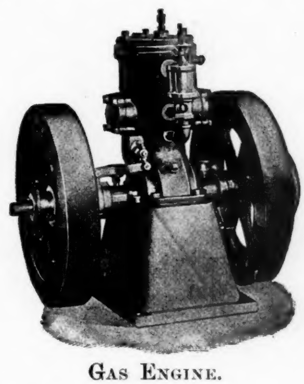
The engine here described is of the two-cycle type; that is, the working cycle is divided into two parts, getting an impulse at each revolution of the crank. The general working of this engine is as follows: The gasoline (which to give satisfactory results should be of the 74° quality) is fed from the tank to the vaporizer, where it is mixed with the proper amount of air and then drawn into the crank case by action of the piston on the upward stroke. It is compressed by the downward stroke, and, as piston uncovers the transfer or inlet port, the compressed charge is forced into the cylinder and again compressed by the upward stroke, and ignited by an electric spark when piston is nearly at top of stroke. The expansion of the ignited charge forces the piston downward, the burnt gases being expelled through the exhaust, which is uncovered by the piston in advance of the inlet port.

It would be well, perhaps, to divide this description under different headings and describe each separately, as follows:

The cylinder, cylinder case, cylinder head, governor, throttle valve, ignition mechanism, piston and piston rings.

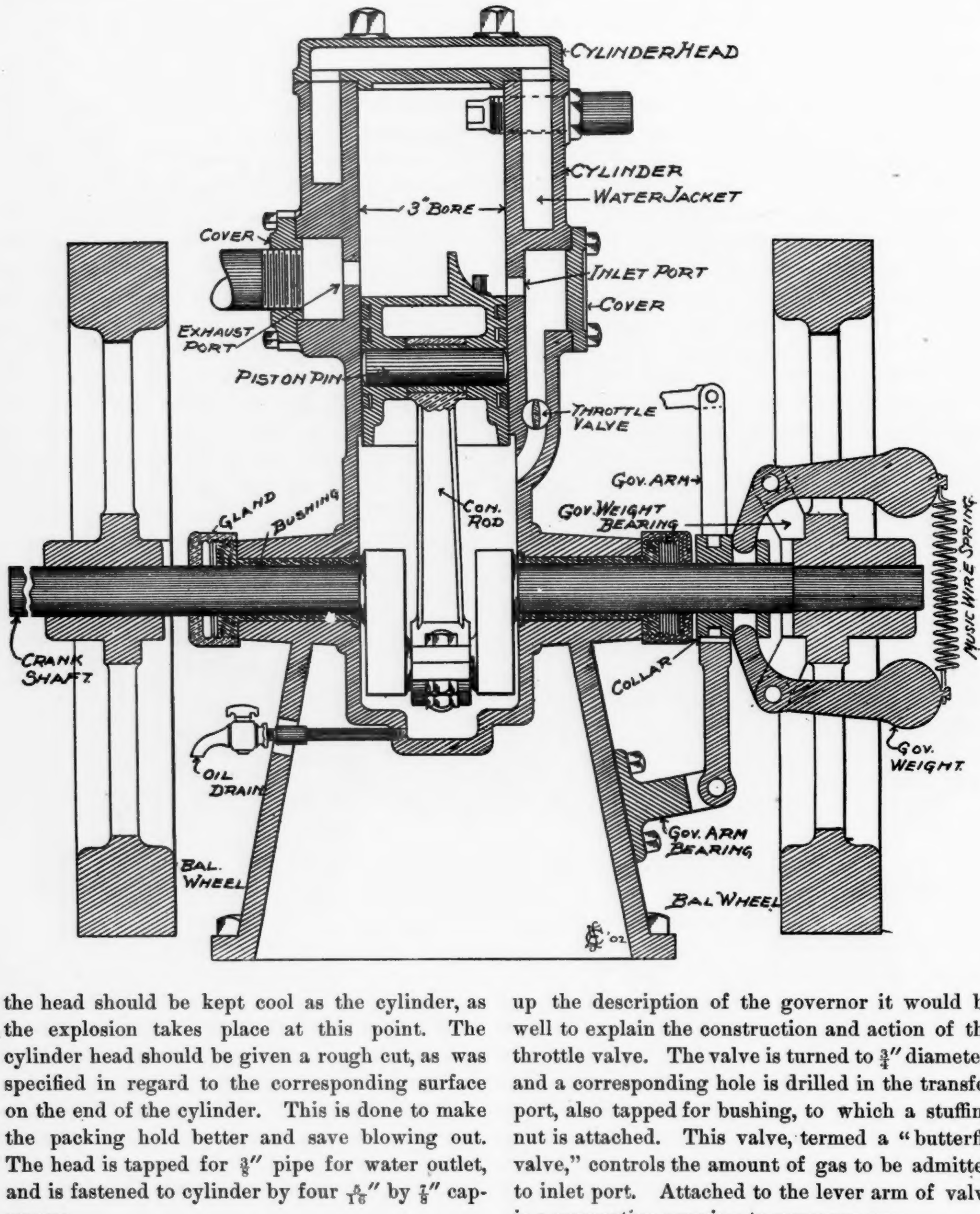
The cylinder (as well as case, head, governor, piston, etc.) is made of cast iron, is bored and reamed 3″ in diameter. The top and bottom are rough-turned to allow tight fit for cylinder head and bottom half of crank case. The port faces are also planed to allow for fitting of covers. The cylinder contains a water jacket, or space of $\frac{1}{2}$″ between outer and inner walls to allow for circulation of water. The reason for this can be better understood with a few words of explanation. The explosions in the cylinder vary from 100 to 500 per minute, so it can be readily seen that the heat to which the cylinder walls are subjected is very great. Should these walls reach a temperature above boiling point, the charge of gas would explode at the wrong moment, causing premature firing; therefore it is essential to use a circulation of water to keep the cylinder cool. It would be well to mention the fact that the boring of cylinder is the most important of all the machine work, as it is essential that the cylinder should be perfectly true and smooth. The cylinder contains two oblong openings, front and rear, to allow for use of tools in cutting ports to the required sizes. The inlet port has two openings, $\frac{1}{2}$″ by 1″, and a $\frac{3}{16}$″ web in center. The exhaust port has two openings, $\frac{5}{8}$″ by 1″, and also a $\frac{3}{16}$″ web in center. At the top of the cylinder are two bosses; one is drilled ($\frac{3}{8}$″ in diam.), to allow for spark pin, while the other is tapped out with a $\frac{5}{8}$″-20 thd. for bushing of igniter lever.

The cylinder case, while answering the purpose of a reservoir for gas, also performs another important function. There is placed in this case a sufficient amount of oil to cover the end of the connecting rod, which becomes lubricated by splashing in the oil. This is considered the best way of ensuring perfect lubrication of this part of the engine; furthermore, it is the safest, as it takes no thought upon the part of the operator. In the side of case is a $\frac{1}{8}$″ pipe tap, for the drawing out the oil.



Gas Engine.

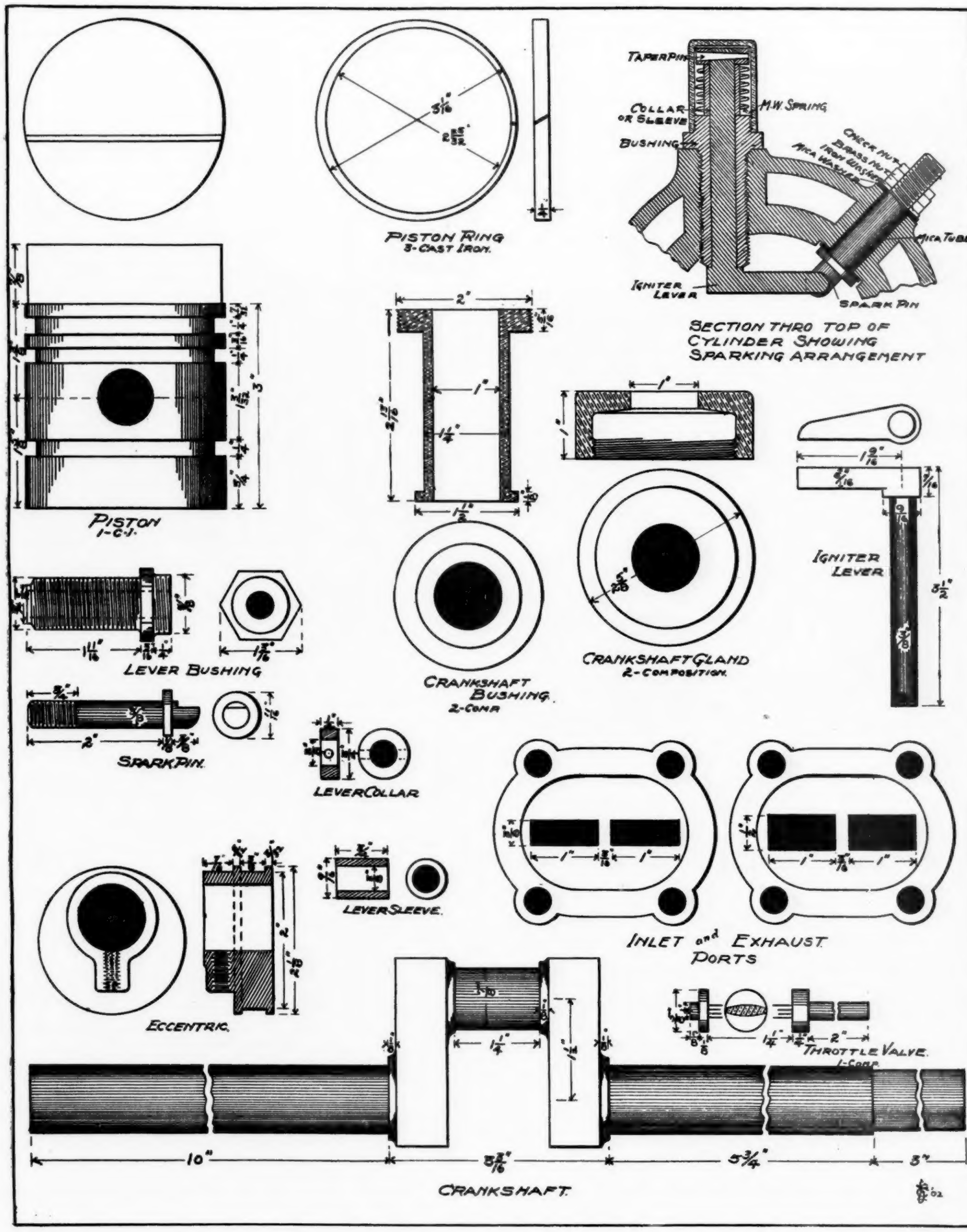
The cylinder head needs but very little description. It contains a water jacket similar to the jacket in cylinder. Two holes are drilled through the face of head, to correspond with holes drilled in top of cylinder, into the jacket to allow for the circulation of water. It is just as important that



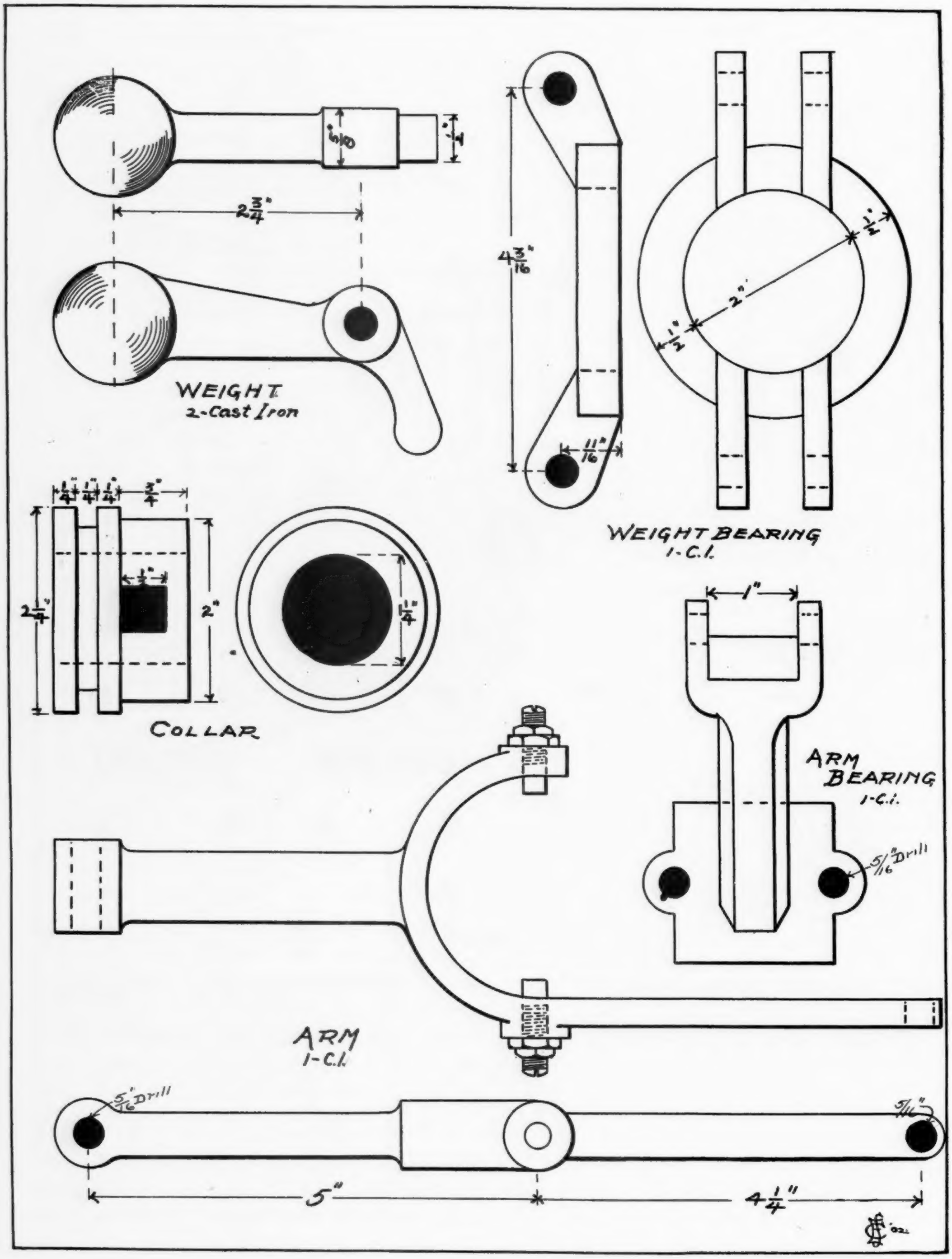
the head should be kept cool as the cylinder, as the explosion takes place at this point. The cylinder head should be given a rough cut, as was specified in regard to the corresponding surface on the end of the cylinder. This is done to make the packing hold better and save blowing out. The head is tapped for $\frac{3}{8}''$ pipe for water outlet, and is fastened to cylinder by four $\frac{5}{16}''$ by $\frac{7}{8}''$ cap-screws.

The above is a general description of the main parts of the engine; we will proceed with the finer and more important portions, drawings of which accompany this description. Before taking up the description of the governor it would be well to explain the construction and action of the throttle valve. The valve is turned to $\frac{3}{4}''$ diameter, and a corresponding hole is drilled in the transfer port, also tapped for bushing, to which a stuffing nut is attached. This valve, termed a "butterfly valve," controls the amount of gas to be admitted to inlet port. Attached to the lever arm of valve is a connection running to governor arm.

The governor comprises two weights, weight-bearing, collar, governor arm and arm-bearing, as shown in drawing. The governor weights are attached to the weight-bearing by means of $\frac{3}{8}''$ steel



pins with split pins on each side, or with capscrews with nuts. The bearing is fastened to the hub of the balance wheel. On the collar, which is bored out to a sliding fit on crank shaft, is cut a $\frac{1}{4}''$ groove. When the weights are in their normal position, the nose of each rests in corresponding holes, which are cored in collar when casting is made. In the yoke of the governor lever are



WEIGHT
2-Cast Iron
WEIGHT BEARING
1-C.I.
COLLAR
ARM
BEARING
1-C.I.
5/16" Drill
ARM
1-C.I.
5/16" Drill
5"
4 1/4"

fastened two steel pins to fit in groove of collar. Fastened to the extension on the arm is a rod running to valve handle. As the speed of the engine increases, the weights are forced out by centrifugal force. With this momentum the collar is drawn outward, thereby drawing the governor lever and closing the throttle valve. The decreasing of speed would consequently allow the valve to assume its former position.

The piston and rings, which should be carefully turned to ensure perfect fit, are made of fairly hard gray cast iron, and will hardly need any description.

The crank shaft bushings are a very important part of the engine, and also the stuffing gland attached to same. These glands, or stuff nuts, not only ensure perfect tightness of crank case, but also add to the length of bearing of shaft.

The sketch of the eccentric can hardly be considered in this description, as it is used only when the circulation of water is forced by pumping. The eccentric is used in connection with the eccentric strap, which operates the pump.

One of the most difficult problems in designing a gasoline motor is the sparking mechanism. It is usually found to be very intricate, made up of numerous levers, cams, etc., which are easy to get out of order. The igniter of this engine has been used and found to be very satisfactory. The method of exploding the gas in the cylinder is known as the "make and break" type igniter, and is so designed that the two points (usually platinum), one on the insulated pin, and one on the arm of the lever, are held together, and then separated with a jerk, by the small pin on piston striking the igniter lever. This makes a quick break in the circuit, so that the spark may have the highest possible voltage at the moment of the break. As the drawings fully show the construction of this part, it will be only necessary to explain the operation of the igniter itself, in order that the action may be fully understood. The spark pin or electrode is set stationary, and insulated by mica tubes and washers, which form the terminus of one side of the circuit. The other electrode or igniter lever is free to rotate on its axis, and is made gas tight, by being ground pointed at the shoulder, against the end of the bushing. This is held in place and under tension by means of the piano-wire spring, which is fastened, one end on the collar, and the other end on the bushing. The collar, if so desired, may be fastened to the lever by a taper pin. The tension of the spring also holds the arm of the lever against the spark pin. The spring is made extra long, as the tendency would otherwise be to shorten when wound and cause an uneven tension, which might cause the lever to bind against the bushing. The small pin, set in the top of the piston to strike the igniter lever, should be adjusted so that it will lift the lever to make the break in the circuit just as the piston has reached the top of the stroke.

It might be well to assure the reader that the dimensions on drawings and in descriptions are correct, and the results obtained from engines which have been built from this design have been more than satisfactory.

BOOKS RECEIVED.

Bookbinding, and the Care of Books. Douglas Cockerell. Appleton & Co., 156 Tremont Street, Boston. 342 pages, 5 x 7½ inches. Cloth, $1.20 net; postage, 8 cents.

Those who are interested in bookbinding will welcome the publication of "Bookbinding, and the Care of Books," by Appleton & Co. The author, Douglas Cockerell, treats the subject in a full and practical way, that will be very helpful to those amateurs who desire to learn to do this work. The professional worker, librarians and book-owners generally, will find in it much valuable information. Numerous illustrations supplement the text very completely, nearly every tool and process being adequately shown. This is the first of a series of "Technical Handbooks on the Artistic Crafts." A volume on "Cabinet Making and Designing," by C. Spooner, is in preparation.

A cable dispatch from Paris of March 1 to a New York daily newspaper reports a curious lawsuit pending between the Nice Observatory and a local electric tram car company using the Thomson-Houston system. The observatory authorities say that the electric instruments in their magnetic department were so much disturbed by the electricity of the tram cars that they were obliged to transport all the instruments to another observatory on Mount Mounier, at a cost of $20,000. They contend that the company ought to pay the cost, and the company is fighting the case.

AMATEUR WORK

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APRIL, 1902

Contents

THE METRIC SYSTEM.

The rapid expansion of the foreign trade of the United States seems likely to produce what years of argument have failed to do; that is, the adoption of the metric system as the general standard for measurements. A bill now before Congress provides that this system shall be the official standard for the various departments of the government. If the bill becomes a law, and it has the support of many influential, commercial and scientific bodies, the general use of the system would follow as rapidly as existing business conditions could be adapted to it.

While the business of this country was almost entirely local, no great necessity seemed to require the change, but with the great increase in trade with foreign countries, most of which required custom and other trade documents expressed in the metric system, the difficulties accompanying the use of two systems have multiplied and given a new aspect to the question.

As the change is towards increased simplicity and ease in calculations and enumerations, commercial necessities will undoubtedly influence a more general recognition of its advantages. The younger generation, with the general training received by technical and other schools, will have no difficulties to contend with, and will undoubtedly welcome and assist in its adoption.

The recent receipt of several interesting articles from readers of this magazine, dealing with subjects already in preparation by regular writers, leads us to request those who contemplate contributing such articles to advise the editor of their title and scope before writing and sending them, thus avoiding duplication of the work. New articles are desired, and will be accepted when treating of subjects not already provided for. The method above indicated will avoid the rejection of articles that cannot be used for the reasons stated.

Several interesting articles that were to have been presented in this issue are omitted, owing to lack of space. They will be inserted in the May number. The size of the magazine will be enlarged at an early date, enabling an increased number of topics to be presented with each issue.

MECHANICAL DRAWING.

EARNEST T. CHILDS.

VI. ORIGINAL STUDIES.

THE subject of sections and section lining has been generally discussed in the last two chapters, and the student needs merely to apply the principles contained therein to obtain satisfactory results. As previously stated, constant application is the price of success, and while the illustrations which are given herewith are good examples for the student, it will be advantageous to go outside and apply these principles on original studies. Let the student take some article which is in daily use, and work up a drawing of it or some of its parts.

For instance, a lawn-mower is familiar to all, but how many know just how it works? This will make an excellent subject for practice, and by the time the student has made a set of detail drawings and an erection drawing, working from the machine itself, he will have acquired a good fund of experience which could be obtained in no better way. The work of measuring up must necessarily be accomplished first, and this will necessitate a sketch or note book, on account of the impossibility of making a neat drawing when working from a dirty, oily piece of machinery. A lawn-mower is, however, no dirtier than many pieces of machinery which have to be oiled. A sketchbook is preferable to a block, as all sketches may be preserved, and oftentimes an old sketch may save time and trouble for the draughtsman. The sketches should, of course, be made free-hand, and as clear and accurate as possible. Due attention must be paid to the relative sizes, so that the sketch will be in good proportion. In other words, make sketches look as much like the object as possible.

In sketching a gear, it will not be necessary to outline every tooth. Simply show two or three and give all the necessary figures for drawing the teeth in detail, covering the number of teeth by a note. It will be found impossible to keep the sketchbook as clean as a drawing, but neatness adds greatly to the ease of reproducing the work on the drawing. If a lawn-mower is not available, a very interesting subject will be a doorknob and lock. Every one can get one of these, and it will be the best possible practice to work up details of the lock and latch complete. These are merely given as illustrations of what may be done.

The important point which must be borne in mind is that original work and original research will be of more help than any amount of copying. When one is working from an object, he can more readily tell just what is most necessary in a drawing to represent that object. The making of free-hand sketches is an important item, and every draughtsman should make it a point to become proficient along this line, as stated above. Care must be taken to preserve the proportions of the object in the sketch.

The novice will experience a great deal of difficulty in making his first sketches, but a little persistence will soon reward him with more and more success. Really, a thorough knowledge of isometric and perspective drawing is necessary, but these are subjects which are to be taken up later. In making sketches of a piece of mechanism, first take the machine to pieces, and then sketch, piece by piece, from the various parts, making one, two or three views of each piece, as may be required. These sketches should be made without touching the parts, in order that the sketchbook may be kept as clean as possible. When the sketches are complete in outline, look them over, and fill in the various witness marks and dimension lines which are required. Then measure the pieces, jotting down the figures in their proper places. This method not only gives as a result a neater sketchbook, but it helps in the making of the working drawing. In making sketches, be careful to do no slack work; make them so that any one acquainted with drawing could use them, and do not trust anything to the memory.

There is one class of sections which has not been described in the foregoing chapters, namely, broken sections. If a portion of a symmetrical object is to be shown, as in the piston rod shown in the last chapter, it is customary to show the broken rod in such a manner as to suggest its shape. This is illustrated by the free-hand sketches (see Fig. 17). These illustrations have been

drawn free-hand, to show the character of work necessary for free-hand sketching.

When a surface is to be finished, it is sometimes helpful to indicate in some manner on the drawing

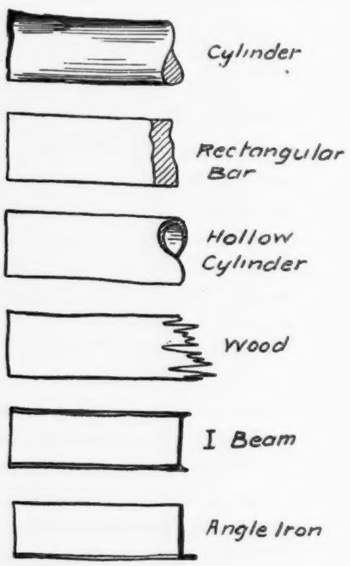


Fig. 17.

that this is the case. The customary way of doing this is to mark a letter "f" through the line which shows the surface to be finished, or to write out the word "finish" in full. The former is the more common. In some shops this is entirely omitted, and it will be seen by referring to the detail drawings accompanying that they have no finish marks. This may be accounted for, in the present instance, by the fact that over one thousand engines of this size have been built from these drawings, and the workmen are sufficiently familiar with the work to render this information superfluous. On new work this detail should never be omitted, and it is particularly essential on drawings from which patterns are to be made, as the pattern-maker has to make a special allowance on work which is to be finished.

In making drawings for structural steel work, it is customary to distinguish on the drawing just what part of the work will be done in the shop and what will be done at the time of erection, or "in the field," as it is termed.

The accompanying sketch (Fig. 18) shows one method which is used by one of the largest steel manufacturers in this country — the Pencoyd Iron Works. This shows at a glance whether a rivet is to be driven in the shop or on the ground, and shows the style of head and which side the head is to be on. The standard dimensions of rivets are as follows:

Diameter shank = 1.

Diameter head = 1.5 + 1/8″ } Finished heads.
Depth head = 0.45

Depth head = 0.50 } Countersunk heads.
Bevel of head = 60 degrees

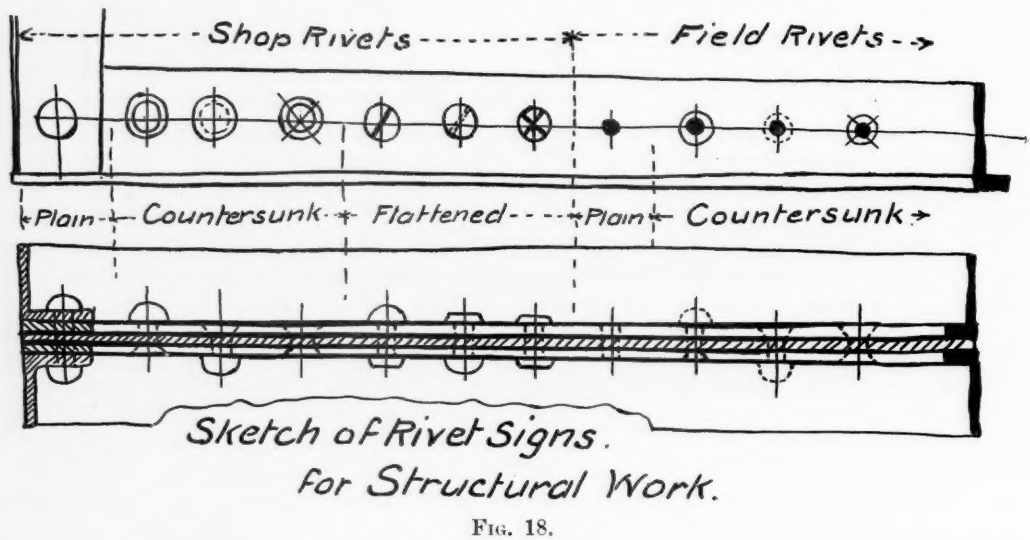


Fig. 18.

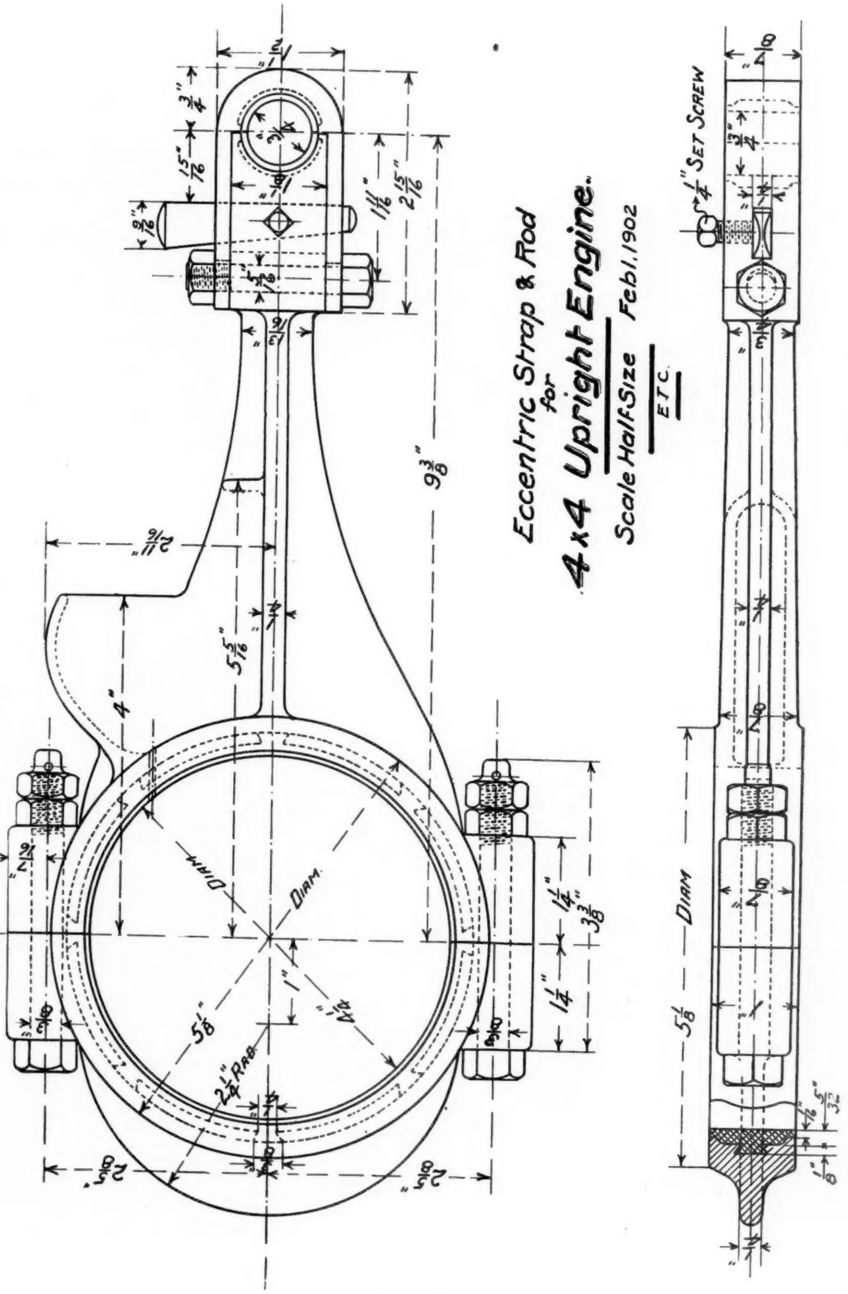

Eccentric Strap & Rod
for
4 x 4 Upright Engine.
Scale Half-Size
Febl.1902
E.T.C.
1/4" Set Screw
Diam
2 1/4" Rad.

Fig. 20.

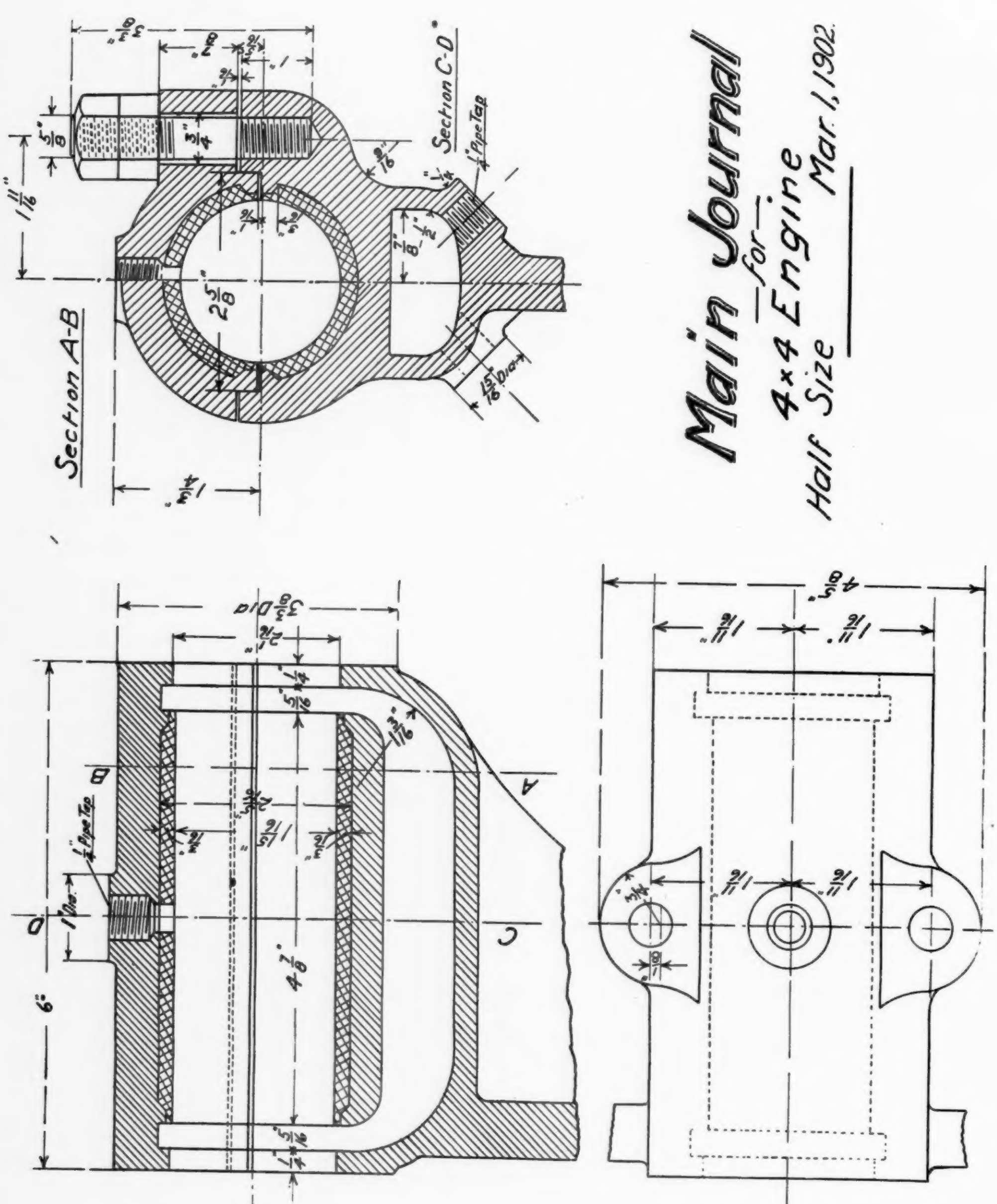

Main Journal
for
4×4 Engine
Half Size Mar. 1, 1902
Section A-B
Section C-D
$\frac{1}{4}$" Pipe Tap

Fig. 21.

Approximate allowance in length of shank for forming finished head over and above length of grip:

$\frac{1}{2}'' = 1''$.	$\frac{7}{8} = 1\frac{1}{2}''$.
$\frac{5}{8}'' = 1\frac{1}{4}''$.	$1'' = 1\frac{5}{8}''$.
$\frac{3}{4}'' = 1\frac{3}{8}$.	

Approximate allowance in length of shank for forming countersunk head over and above length of grip:

$\frac{1}{2}'' = \frac{5}{8}''$.	$\frac{7}{8}'' = \frac{7}{8}''$.
$\frac{5}{8}'' = \frac{3}{4}''$.	$1'' = \frac{7}{8}''$.
$\frac{3}{4}'' = \frac{3}{4}''$.	

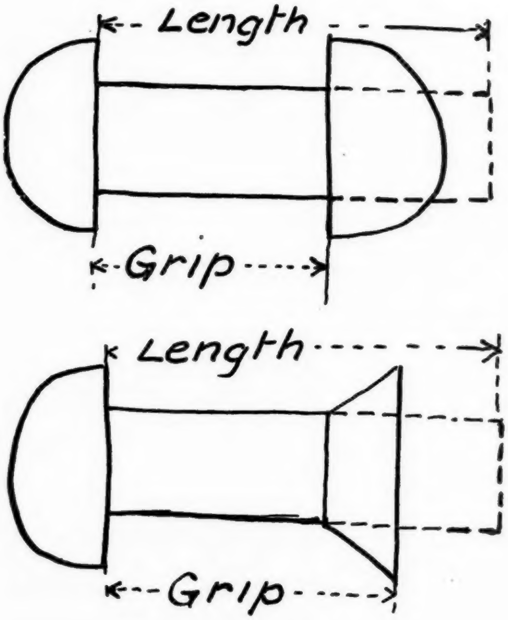


Fig. 19.

For round head add $\frac{1}{8}''$ to length for each additional inch of grip; for countersunk head add $\frac{1}{8}''$ to length for each additional two inches (2″) of grip. (See Fig. 19.)

The examples for practice in this chapter comprise details necessary before presenting the assembly drawing complete, which will be given in the next chapter. The eccentric strap (Fig. 20) is shown entirely in outline, except that a partial section is shown of the lower half. This was necessary to show the method of holding the Babbitt metal. This will give excellent practice in the use of an irregular curve, and also in the representation of nuts and threads.

Fig. 21, showing the main journal, is a very interesting study. This journal is cast directly to the engine frame, as is indicated by the broken lines; and it is of cast iron, as is indicated by the character of section line. The longitudinal section is shown on the center line, and no special note is necessary. The cross section is broken, the left-hand half being on line AB, and the right-hand half on line CD, thus giving in one drawing three distinct sections.

MAKING PRINTS.

Frederick A. Draper.

The amateur photographer will have made but little progress towards artistic results if the making of prints is not included in the work attempted. This is because the wide range of effects obtainable from a single negative, by using different printing papers, enables the operator to experiment until the desired result is secured. This experimental work with prints also affords valuable information regarding the making of the negative; these two parts of photographic work being dependent upon each other for the final result, the finished print. The amateur who is desirous of doing artistic work should certainly attempt print making as soon as possible after good negatives are being secured.

The necessary equipment includes printing frames, two or three trays, printing paper and the solutions required for toning and fixing. For those who have little or no leisure time during the day, a "gaslight" paper will be the most satisfactory to begin with, and this kind will be considered first. That known as "velox" will probably be most easily obtained by readers of this magazine, as it is for sale by almost every dealer of photographic supplies. It is made by the Nephera Chemical Company, which issues a pamphlet giving directions for its use, and also manufactures the necessary solutions for working it. It is always well to use the chemicals prepared by the maker of a paper, as the responsibility for good results is then solely with one party, in addition to the advantage that the chemicals used were intended for that particular kind of paper.

Of the many varieties of velox, the "regular carbon" and "special carbon" will answer for the first trials. Care should be taken to secure

fresh paper, and paper that is thought to be old should not be accepted.

If gas is used, a Welsbach burner is very convenient, as it gives a large volume of light, and varies but little in intensity at different times. A central draught lamp with a glass reflector gives a good light. A table or other support is necessary, with some arrangement for holding the printing frames so that the negative will be exactly in line with the light, and always the same distance from it. The essential point is *uniformity of exposure* to the light, after the necessary time and distance has been once determined.

The package containing the paper should be opened in dim light, and the sheets not used kept covered. A book may be used to hold the necessary sheets previous to printing, thus avoiding the necessity of opening the original package each time. With the first few trials, and until one is quite familiar with the paper, a piece may be cut into narrow strips, with which exposures are made, and the strips developed until the correct exposure is learned. In handling the paper, the sensitive side of the paper should not be touched with the hands, as marks are likely to appear on the print if this is done.

Velox is a paper on which the image is not visible until developed. The process is quite similar to that for developing a negative. After the paper has been exposed, it is immersed edgewise and face up, in a tray containing the developing solution. The tray should be somewhat larger than the print to facilitate handling. The print should be evenly covered with the developer as quickly as possible, so that its action may be uniform. This should be done in a dim light.

If the exposure has been right, the image will appear gradually; and if "regular" paper is used, will be fully developed in about 15 seconds. "Special" paper takes about twice as long. If the print flashes up and grows black rapidly, it has been overexposed. Remove at once and add a few drops of bromide solution to restrain the action of the developer. Rinse once in clear water and continue the development.

When development is completed, rinse in clear water for a short time to remove the surplus developer, and then immerse in the fixing bath. When in this bath, the prints should be kept moving to secure uniform and thorough fixing, and to prevent stains resulting from uneven action of the bath on different parts of the print. Remember that the hands should always be washed without soap and well dried when changing work from developer to fixing bath or the reverse. A tilting holder for trays can be purchased for a small sum, or can easily be made of wood, and, with a glass rod for moving the prints in the bath, the necessity for often washing the hands avoided.

The prints should remain in the fixing bath for 10 to 15 minutes, then placed for an hour in a tray into which water is running slowly from a faucet, or which is changed eight or ten times. The prints should be changed around so that all parts may be cleaned of the fixing solution. In warm weather the time for fixing may be shortened somewhat, or else the tray containing the bath be placed in a larger tray containing water kept cool with small pieces of ice. Use plenty of the fixing bath, and then wash it off very thoroughly. If the washing is not complete, the prints will fade in time. The prints are most conveniently dried by placing them between layers of blotting paper, but this paper must be free from chemicals. Suitable paper may be secured without difficulty. Cut and folded into a book, a few sheets will answer for quite a number of small prints.

The peculiarities of one kind of print being learned, other kinds can be attempted. Bromide, platinum, carbon, blue-prints and bichromate prints all afford interesting possibilities, limited only by the time and inclination of the worker. They all have their special advantages, and are used to produce special effects. The general process of printing one kind having been well learned, the taking up of the others presents but few problems. The increased interest and knowledge resulting from doing one's own work, more than compensates for the short time required to master the essentials of the process.

A STONE which a workman was dressing exploded recently at the Cartnell quarries, Thorold. Several accidents of similar character have occurred there. The quarry is leased by the National Contracting Company of New York. It is thought moisture had got into the blocks, which, freezing, caused them to burst with great force.

PING-PONG, OR TABLE TENNIS.

How to make the Necessary Parts.

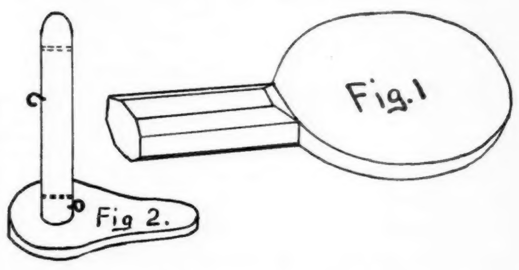
While not a new game, it is only during the last two seasons that table tennis has become well known and generally played in this country. Probably no indoor game affords more healthy exercise, together with sustained interest, than does this one. As the necessary parts, with the exception of the balls, are easily and cheaply made, every one desiring to play the game may do so at little expense. The balls may be obtained from any dealer of sporting goods at 50 to 75 cents per dozen. One-half dozen will last for quite a long time.

The dining-room table will answer nicely provided the leaves are level. A cover of billiard cloth may be used if desired, but the bare board is better. The required space is 9′ long and 5′ wide, and the height should be about 2′ 6″. The rules of the game are the same as for lawn tennis, with the exceptions that no volleying is allowed, and the service should be underhand and from behind the table.

If a dining-room table is not available, a table can be made after the plan of a drawing-board and in two sections. Wide matched pine or whitewood will be the most suitable, the division coming in the center, where the net crosses. The joints of the boards should be carefully smoothed, all the cracks puttied, and then a coating of dull, dark paint applied. The service lines are then painted across each half, parallel with the ends and 31″ from the center. These should be $\frac{1}{2}$″ wide and are connected by a center line, the same width and parallel with the sides. This divides the table in sections of the same shape as for lawn tennis.

If a dining-room table is used, the divisions can be made with tape, the end of which may be temporarily fastened onto the underside of the table top with small tacks. If the table is wider than necessary, side tapes should be placed so that the playing width will measure only 5′.

The battledores or rackets are made of whitewood in the shape shown in Fig. 1. They are $\frac{3}{8}$″ thick, 7″ long and 5″ or $5\frac{1}{2}$″ wide. The handles are built up by gluing on extra pieces of the same thickness, and then worked out round or octagonal as preferred. The body should be perfectly flat and smooth. A coating of thin shellac will give a good finish. After the shellac is dry, smooth the body with fine sandpaper. The supports for the net are shown in Fig. 2. The base is $\frac{1}{2}$″ thick, the bottom being covered with leather or felt, which is glued on, to prevent scratching the surface of the table. The post is a round piece of wood $\frac{7}{8}$″ in diameter and 8″ high, firmly set in a hole in the base. An old broom handle can be cut up for posts. One inch above the base a hole $\frac{1}{8}$″ in diameter is bored through to receive the lower cord of the net. Another hole 6″ above the base receives the top cord. A screw-hook on the out-



side of the post is used for fastening the ends of the net cords. Two cheap iron or wood clamps are used to hold the posts firmly to the table during the game.

The net, which is 5′ long and $6\frac{1}{2}$″ wide, is made of bobbinet, or any coarse curtain lace. The top is bound with inch-wide tape, and the bottom finished with a narrow hem through which a heavy cord is drawn. Also draw a heavy cord through the tape at the top, leaving ends on each cord long enough for tying to the posts. The net is supported by the cords, and the top edge should be $6\frac{1}{2}$″ above the table. This height may be varied between 5″ and 7″.

Rules of Ping-pong.

1. The game is for two players. They shall stand one at each end of the table. The player who first delivers the ball shall be called the server, and the other the striker-out.
2. The server shall stand behind the end and within the limits of the width of the table.
3. The service shall be strictly underhand, and from behind the table; that is to say, at the time of striking the ball the racket may not be over the table, and no part of the racket, except the handle, may be above the waist.
4. The ball served must drop on the table top beyond the net, and is then in play. If it drops

into the net or off the table, it is called a "fault," and counts to the striker-out.

5. There is no second service, except when the ball touches the net or posts in passing over and drops on the table, beyond the net, when it is called "a let," and another service is allowed.

6. If the ball in play strikes any object above or around the table before it drops on the table (net or posts excepted), it counts against the striker.

7. The server wins a stroke if the striker-out fails to return the service, or the ball in play.

8. The striker-out wins a stroke if the server serves a "fault" or fails to return the ball in play, or returns the ball in play so that it falls off the table.

Scoring.

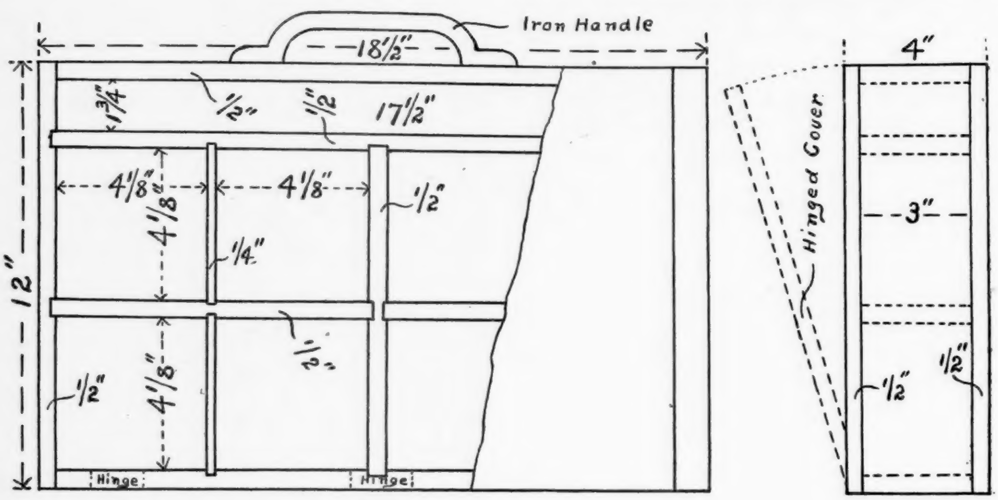
On either player winning his first stroke, the score is called 15 for that player; on either player winning his second stroke, the score is called 30 for that player; on either player winning his third stroke, the score is called 40 for that player; and the fourth stroke won by either player is scored game for that player, except as below.

If both players have won three strokes (40 all) the score is called "deuce," and the next stroke won by either player is scored "advantage" to that player. If the same player win the next stroke, he wins the game; if he loses the next stroke, the score is again called "deuce," and so on until either player wins the two strokes immediately following the score of deuce, when the game is scored for that player. The player who first wins six games wins a set.

CASE FOR SHOTGUN SHELLS.

J. A. Phillips.

The little wooden case for shotgun shells which I have just made for my own use is a very handy article, and if a person can make it himself, is an inexpensive one also. I made my box of white pine, carefully gauged as to thickness, so as to make a nice job. It is snugly grooved together and fastened with screws to make it perfectly secure. The cover has grooved strips across the ends, as shown on the right of the illustration. These strips are to keep the cover from warping. Three hinges are used on the cover, and a lock at



Shotgun Case.

the top for fastening. The handle is of iron or brass, as preferred.

If preferred, the box can be made of mahogany, maple or other wood, and finished natural with brass ornaments. Whitewood stained a cherry or mahogany color also would look well. It is important to have the wood of exact thickness, so that the fitting of all the joints will be snug and strong. The outside corner joints can be dovetailed to good advantage.

The case will hold two hundred 12-gauge shotgun shells and has space at top for wiping rod, oiler, cleaning materials, tools, etc.

STUDIES IN ELECTRICITY.

VI. Magnetic Field and Polarity.

The space all around a magnet over which the magnetic forces extend is termed the "field." These forces vary in strength, being strongest near the poles and growing weaker as the distance from the poles increases. The direction in which these forces act also varies with the different parts of a magnet, but this variation is along certain well-known and regular lines. This may be shown in a very interesting way by the following experiment: Over a bar-magnet place a sheet of smooth writing paper; on the paper, dust some fine iron filings. As they settle down they will form lines similar to those shown in Fig. 20. It may be necessary to gently tap the paper a few times to have the lines clearly shown.

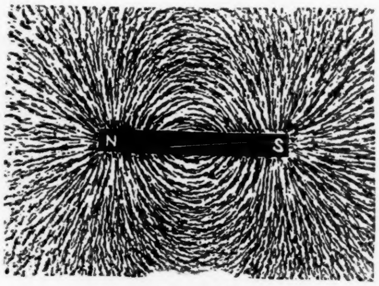


Fig. 20.

This figure may be made permanent by using gummed paper, which may be moistened by steam, after the filings are arranged, and then allowed to dry. When dry, the filings will be firmly attached to the paper by the gum. Attention is directed to the way in which the lines diverge from each pole, and those along the magnet curve toward each other. These lines are known as the "lines of force," and are a visible illustration of these lines, which act in all directions from a magnet.

Other instructive experiments are made by replacing the bar-magnet with the N and S poles of two bar-magnets slightly separated, as shown in Fig. 21; also using the two N poles and a single N pole, and, with the iron filings, determine the lines of force developed on the sheet of paper. How the lines of force are utilized in dynamo, motor and other electrical devices will be considered later.

In the last chapter we learned that the magnetic polarity, in the several experiments, was dependent on the direction of the current. It is important that this should be clearly understood

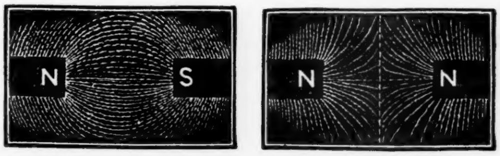


Fig. 21.

and remembered by the student. Referring to Fig. 15 and the experiments connected therewith, the following rule, suggested by Ampere, should be memorized: "Suppose a man swimming in the wire with the current, and that he turns his head so as to face the needle, then the N-seeking pole of the needle will be deflected towards his left hand." Another convenient rule, known as the "corkscrew" rule of Maxwell, is, "The direction of the current and that of the resulting magnetic force are related to one another as are the rotation and forward travel of an ordinary (right-hand) corkscrew." (See Fig. 19.)

The experiments previously described show that the magnetic attraction is variable and dependent upon several factors, which are: *a*, the amount of the current flowing; *b*, the number of turns of wire; *c*, the size of the conductor.

There is a limit, however, beyond which the magnetic force of a coil cannot be developed. This is known as the saturation limit or saturation point.

If a core of soft iron be wound with one layer of wire carrying a current of one ampere, a certain weight of iron may be lifted thereby. If another layer of wire be added, the current may be reduced nearly one-half without diminishing the lifting power. Another layer of wire will enable a still further reduction in the current. Successive layers of wire may be added with proportionate reductions in the current, until eventually the final layers produce little or no addition to the

magnetic force developed, because the resistance of the wire equals or exceeds the magnetic force developed. It is because of this fact that the secondary winding of an induction coil cannot be increased indefinitely, but bears a fixed relation to the size of the primary winding and core; hence the expression of "ampere turns" as applied to wiring of electrical devices.

From this also arises the necessity of calculating the relation of battery strength and force, and the number of turns and size of wire. With a battery of high E. M. F., but low current, more turns and finer wire are necessary than with a battery of large current or high amperage, with which fewer turns and larger wire may be used. The saturation capacity of the wire regulates the maximum number of turns to be given a coil.

Though extremely rapid, a certain time is required for magnetic action, and also for demagnetization to take place. If an electro-magnet is to be rapidly excited, it should be short and thick, as the action of such a form is quicker than with a long one. If a strong, slow action is required, a long electro-magnet is the better.

Referring again to Fig. 19, if the iron core be omitted from the coil or spiral of wire, the coil will, when excited by a current, act as an electro-magnet, though with much less power than with the core. Such a coil is termed a "solenoid," and will attract and repel other solenoids, electro-magnets, and, in fact, present the same phenomena as do electro-magnets. The magnetic field of a solenoid is strongest within the coil, and the core is most strongly magnetized when placed therein, though more or less magnetized whenever within the lines of force of the coil. Certain electrical instruments are simply one solenoid within another. When the interior one is movable, it is termed a "sucking solenoid," the inner one always tending to move into the position in which it best completes the magnetic circuit. If a solenoid be suspended so that it can turn freely, it will, when influenced by a current, set itself in the direction of the magnetic meridian, the same as does an ordinary compass.

Castings for the motor described in the March number are being made, and will be offered as a premium for new subscribers.

HOW TO MAKE CABINET FITTINGS.

Handycraft.

The amateur woodworker, especially in the small towns, generally has trouble in procuring fittings, such as escutcheons, hinge-plates, etc., and it is the purpose of this article to show how they can be made at home at a very small expense. For the purpose will be required some 24 to 30 gauge sheet brass and some pieces of hard thin wood, say about $\frac{3}{16}''$ thick, such as is used for fret-sawing. First, draw on one piece of the wood the design, as shown in Fig. 1 at A. Then

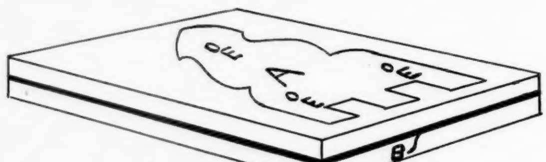


Fig. 1

place a piece of brass of suitable size between two pieces of wood, as indicated at B. Drill the holes, E, through the top piece of wood and the brass, which will be the holes for screws in the finished escutcheon, and put small screws through into the bottom piece. With the two pieces of wood and brass fastened between them, it is an easy matter to saw out with a strong fine-toothed fret-saw the keyhole and around the edge, and, with a little filing and polishing, a very nice-fitting ornament can be made.

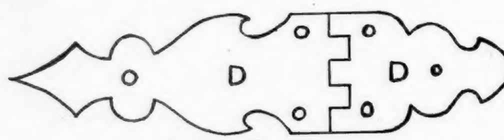


Fig. 2

In Fig. 2 D represents a folded hinge made in the same manner as described for Fig. 1. If the amateur is handy with a graver, scrolls can be cut on the surface which will add to the looks, but a nicely polished surface looks neater than poorly cut scrolls.

The above is just a hint, and may interest some of the readers of Amateur Work to the extent of making some very pretty additions to their cabinet work.

WIMSHURST INFLUENCE MACHINE.

(Continued from page 130.)

From the remainder of your No. 10 brass wire cut two pieces 8″ long, and tip with the two remaining brass balls, as described before. A hole is pierced in the center of each cork and cap, and the brass rods are pushed through the holes to a depth of three inches. The rods should fit tightly in the corks, so that they cannot drop down. A piece of thin, bare copper wire about 8″ long is now soldered to the lower end of each brass rod, and the corks and rods are set in the mouths of the jars, taking care that the copper wires touch the inside coatings of the jars. The condensers being now completed are set on the base H, as shown in Fig. 7, the brass rods being in contact with the arms W, and the bottoms connected with each other by a strip of tin foil pasted on the base.

Let us now try the machine and learn if it will work. In the first experiment we will remove the condensers temporarily, and setting the discharge balls within 1′ of each other, we turn the crank of the machine from left to right. After about twenty turns of the crank the machine will run harder, which shows it is generating, and a stream of sparks will flow between the discharge balls. These may now be separated to about 1¼″, and the sparks will still continue to flow. A separation of more than 1½″ will stop the sparks, and what is called the "brush" discharge begins. This consists of a stream of pale blue electricity bursting out from the right-hand discharge ball, and is accompanied by a strong smell of ozone. This discharge is quickly attracted by the approach of any conductor, such as the hand, and the sensation when the brush touches the latter is like the feeling of fine cobwebs.

As the machine is found to generate correctly, we will replace the two condensers and proceed to discharge them. See that the brass rods of the condensers touch the arms, W, leading to the discharging rods, and that the bases of the jars are in good contact with the tin-foil strip on the base. Now turn the machine again, having set the discharge balls about 3″ apart. A much larger operation of the machine is necessary in this case; but very soon a decided resistance is felt, and a thick white spark will strike between the balls with a quite startling report, and this will be repeated about every fifteen turns of the crank as long as the machine is in motion. On cold days I have been able to get as much as five inches of spark from my own machine.

I would say here that care should be taken not to approach the face or hands near the bare metal of the machine, as it is quite possible to get a very powerful and unpleasant shock from it when the condensers are attached. Use the wooden handle shown in Fig. 4 to regulate the length of the spark gap. There are hundreds of experiments which can be performed with this machine, but a description of them is not within the scope of this article, as they can be found in any elementary book on physics. I have appended a list of the prices of the various materials used in building this machine, and have set a maximum cost on each article, to be on the safe side. The list could, no doubt, be scaled down by most amateur workmen by the use of materials to be found in almost every household. I hope that the directions given in this article will enable the aspiring amateur to build the machine to his satisfaction, and that he will have as much pleasure from its use as I have had from mine.

List of Materials.

Wood for frames of glass drill and machine	$ .60
Three-quarter-inch copper tube for drilling glass	.10
Emery powder and turpentine	.10
Two 15″ glass plates, cut to order	.50
Nine feet of No. 10 brass wire	.10
Sheet brass 10″ x 4″ No. 26 Stubbs gauge	.10
One-quarter-inch smooth round-steel bar 10″ long	.15
Two hard-rubber tubes 9½″ long	.50
Nine ½″ brass balls	.27
One ¾″ brass ball	.05
Ten sheets 6″ x 8″ tin foil	.75
Shellac varnish (white)	.10
Van Stan's cement	.05
Two 4″ screw pulleys	.30
Iron rod for axle for pulleys	.10
Six feet ¼″ round belt at 10c.	.60
Tinsel or sheet copper for brushes	.05
Two pint jars (white glass) for condensers	.20
Corks for jars	.10
Screws, nails, copper, wire, etc.	.25
	$4.97

HOW TO BUILD A HOUSEBOAT.

Carl H. Clark.

III. Interior Furnishings.

The carpenter and joiner work on the hull and house previously described about completes that portion of the work. All that remains is to put in the inside fittings and furnish according to one's taste.

While the arrangements as laid out in the preceding chapters seem to give the best accommodation, the positions of the various articles of furniture can be changed around to suit individual preferences.

If preferred, the rooms can be left plain, and all the furniture set into place as in a house; but it will be better to build certain things in place, on account of its being cheaper and allowing a better economy of space, which is most important on a boat.

In the living-room the two seats shown are designed to be used as seats during the day and as berths at night, the bed linen being stored under them in the daytime. They should be about 2′ wide and about 15″ above the floor. The front is a 2″ x 4″ joist on edge, supported from the floor by pieces of board at each end; the top is covered with short pieces of board, and it is sheathed up in front with short pieces of sheathing. A cleat on the side of the house will hold up the back of the seat, and one on the floor will hold the lower end of the sheathing. A piece of the top is left loose to give access to the locker below. A piece about $2\frac{1}{2}$″ wide and $\frac{1}{2}$″ thick is nailed on edge across the top to cover the rough ends of the boards. The upper edge projects about $\frac{1}{2}$″ above the seat and holds the cushions in place.

The beds are designed to be of ordinary springs supported on a framework of 2″ x 4″ joists; that in the large room being a full-size spring, while those in the small room are single springs. It will be well to sheathe up around this framework and to fit in large drawers, as this makes excellent storage space for clothes, etc.

In the smaller room, where two berths are shown, the lower is built as above, but the upper is best made to fold up when not in use. A box about 6″ deep is made to just fit the spring, which is set into it; it is then fastened to the wall by strong strap-hinges, and supported by chains at the front corners when down for use. A strong hook on each corner will hold it up when not in use.

Of course one may use regular bed-frames, but the room under them cannot be used to such good advantage. It will be better to put in ready-made dressers, as they are cheaper and neater than those built into place.

The washbowls, sink for the kitchen, bathtub and closet can be bought from any dealer in plumbers' supplies. In setting the sink and bowls, all that is necessary is to build a frame at the proper height with a hole to fit the bowl, which is then set into it. The space under the bowls in the rooms should be sheathed in and a door fitted, making a convenient locker.

The drains are, of course, made of lead pipe soldered to the outlet from the bowls, and led down outside the hull through a hole, coming out just under the guard. The lead pipe must be allowed to project out from the hull at least 2″ to prevent the drip running down and discoloring the paint. If running water is to be fitted, a faucet must be provided and pipe connections leading to the supply-tank.

The water-tanks are to be put in the hull below deck. Unless the tank is put in before the deck beams are in place, two or three small tanks will have to be used. Whatever the shape of the tanks, they must be placed with their longest dimension fore and aft. For convenience, a filling pipe can be led from each tank to the deck. Unless water is easily obtainable, it will be necessary to have tanks large enough to hold several days' supply, to avoid the inconvenience of frequent filling.

Running water may be provided by a small tank on the roof, large enough to hold at least a day's supply. The pipes from the faucets all lead to this tank, which is filled as necessary, either by hand or with a force-pump below.

Another way, which is better and not expensive, is to have a heavy tank in the hold large enough to hold a day's supply and capable of standing some pressure. The pipes to the faucets are connected directly to the lowest point of this tank, and a connection is also made near the top for an air-pump, with a valve on the tank. A large bicycle foot-pump will answer for this, with a rubber connection. By pumping air into the pump, the pressure can be raised enough to force the water through the pipes to the faucets. It may be filled by a direct connection to the main tanks, the water flowing in by its own weight. It must, of course, not be filled full, as some space must be left for the air. This way is much neater than the other, besides being less laborious, but care must be taken not to leave the taps open and the water running when not wanted. If it is not considered desirable to furnish running water, the closets under the washbowls can be fitted to hold a water jar, which is filled when necessary.

It will probably be best to fit the kitchen with a hand-pump leading to the main tanks, as the large amount of water used here would be a tax on either of the systems described.

The best way to supply the bathtub is by an independent hand-pump. There should be two pipes leading from this pump, with a valve in each, one leading to the tanks below, and the other leading overboard on the opposite side from the water-closet discharge.

Opening one valve and closing the other, water can be drawn from either source. The drain from the tub can be led out under the guard.

The closet should be of the marine type, with pump connected. Directions for setting come with the closet. The discharge should be below the water line. Where the plank is cut for this discharge, a re-enforcing piece should be fitted on the inside of the plank between the frames, and the opening cut through both this and the plank. Great care must be used in making the joint where the discharge comes out. The pipe will probably be about 4″ in diameter, and the hole should be cut to fit it as closely as possible. A circle should then be drawn around the hole about 1½″ larger, and the plank cut away to a depth of about ⅛″. The lead pipe is then bent to shape and allowed to project about 2″ from the hole. With a light, round-nosed mallet, the end of the pipe can be flanged out to a right angle all around, and then trimmed off to fit the circle. It can then be drawn out enough to put a thick coat of white lead underneath, and then put back and closely tacked with copper tacks. This is a rather fussy piece of work, and must be carefully done, or it will always leak and be a source of great annoyance. The discharge from the closet must be as straight as possible, with no sharp bends, to avoid clogging, and should be in as inconspicuous a place as possible.

The several shelves and lockers in the kitchen are to be conveniently arranged for cooking purposes. The stove is an ordinary range, although there may not be room for one of a large size. Where the stovepipe passes through the roof, the planking must be cut out enough so that the heat will not char it. Either a close-fitting piece of zinc or a ring which is sold for that purpose, will serve to fill up the opening around the pipe. Some kind of ornamental cap is fitted over the top of the pipe.

Some means must be taken to get rid of any water which may enter the hull. A bilge-pump can be arranged on the after-deck. It might be advisable to have one at each end, as the water will run to the lowest place. A good pump for this place is one which is attached to a brass plate with a screw top; the plate is set into the deck flush, and by unscrewing the cap, the rod and bucket can be inserted and the pump is ready for use, one rod and bucket serving for both pumps. The pumps may be set in place, and a piece of hose used for the lower connection, which may be shifted about to wherever the water may lodge.

When the boat is afloat, she will probably not float evenly, being lower at the after-end, and ballast will be needed to bring her down even. It will be well to put in considerably more than is necessary for this alone, as it will make the boat much stiffer and less sensitive to the movements of those on board. Flat stones will answer very well for ballast, and should be placed in a rough board box.

No arrangements have been made for steering, as this has not been thought necessary for the little the boat is likely to be moved, especially as, by using a bridle for towing, she will follow all right. This bridle is a piece of rope leading from each forward bitt and meeting about 30′ ahead, where the towline is attached. This makes the boat tow steadily and prevents sheering off.

For flying a flag, a pole on the forward end of the house may be desirable; it must, however, be as light as possible, on account of its height above the water. If it is wished to hoist a tender aboard, a pair of davits can be fitted on the after-end. Just before being put into use, the outside of the boat should have a thin coat of paint, and it must be remembered that paint does not last as long on the water as on shore, and it will need renewing oftener.

When she is first put into the water, she will probably leak some, but in a few days she will swell up tight. If these directions are followed, and the work done with even a reasonable degree of care, there is no reason why both hull and roof should not be perfectly tight and cause very little trouble.

VENTING COOKED CORES.

Boston, Mass., March 7, 1902.

As all foundry-men know, the making of a successful core requires a lot of time and patience. I speak now of crooked cores which require venting in every direction. A way is herewith suggested which ensures a perfect vent in every core, and takes far less time than the method often used.

While the core is being "rammed up" a small wax wire is laid in; it makes absolutely no difference how crookedly it is put in, so long as it is all inside the core, with the ends only projecting. The core is then put in the oven and baked, after which process it is ready for the mold. In baking, the wax wire has melted and disappeared, leaving nothing in its place but a free and open venthole. It is even better for straight venting than an iron wire, because the walls of the hole are, of course, lined with the wax, and no particles of sand can fall in to plug the vent, let alone the risk of breaking the whole core by pushing, or trying to push, an iron wire through it.

This process is not theoretical; it has been tried and proved very successful.

The wax wire is made by squeezing beeswax through a hole of suitable size drilled in a piece of sheet steel.

H. D. W.

A dispatch from Memphis, Tenn., says that the Southern Pacific Railroad is making elaborate preparations for the use of oil as fuel through that system. The company intend to establish steel tanks of 50,000 barrels average capacity along their lines. It is stated that the company intend to use oil for generating power on the locomotives from one end of the line to the other, and eventually on their engines, ferryboats and steamboats.

CORRESPONDENCE.

Our readers are invited to contribute to this department, but no responsibility is assumed for the opinions expressed in these communications.

Letters for this department should be addressed to Editor of Amateur Work, 85 Water Street, Boston.

They should be plainly written on only one side of the paper, with a top margin of one inch and side margins of one-half inch.

The name and address of the writer must be given, but will not be used, if so requested.

Enclose stamps, if an answer is desired.

In referring to other letters, give the number of the letter referred to, and the date published.

Illustrate the subject when possible by a drawing or photograph with dimensions.

Readers who desire to purchase articles not advertised in our columns will be furnished the addresses of dealers or manufacturers, if stamp is enclosed with request.

(No. 9.) Humber Bay, March 3, 1902.

(*a*) Could an induction coil be used to ring a magnet bell one mile distant instead of a magneto-machine, using two batteries for primary?

(*b*) If the current going through the primary winding of an induction coil is two volts and three amperes direct current, would the results given by the secondary be different if the current was alternating at the same amperes and volts?

I am pleased to say that the induction coil made from instructions in the magazine works finely. B. C.

(*a*) While never having tried to ring a bell over a long distance, by increasing the voltage with an induction coil I should think it could be done. A magneto-machine is better and no more expensive.

(*b*) The only difference in the current given by the secondary, as above stated, is that in the first case the curve illustrating the drop in voltage between impulses is sharp, while with the alternating current it rises and falls at about the same rate.

(No. 10.) Bristol, R. I., March 9, 1902.

In the correspondence column of the March number you state that for an induction coil giving a one-half-inch spark one pound of No. 40 covered magnet wire is required. This costs $20, which is more than a complete Ruhmkorff induction coil can be purchased for. I do not understand how this difference in price comes. C. B. R.

The coils you mention are probably imported German or French instruments, and usually are not made with covered wire, but with bare wire with thread between and shellac or some other insulating material used to replace the wire covering. It would not be advisable for any one who was not very experienced to attempt to make a coil in this way. The directions given in this magazine are those thought most likely to produce successful results and most suitable for the amateur.

(No. 11.) Boston, Mass., March 15, 1902.

Will you please publish a description and drawings of wooden works suitable for the clocks recently described in the magazine? A. S. W.

A descriptive article on wooden works for these clocks is now in preparation, and will be published as soon as completed.

(No. 12.) Toronto, Ont., March 10, 1902.

Where and at what approximate price can one procure the works for the clock described in the December number by John F. Adams? I am building the frame, and desire to know where to get the works. F. C. S.

The best movement that can be purchased at low cost is probably the one made by the Seth Thomas Clock Company, Thomaston, Conn., No. 85A; cost, $7.50. It is eight-day, pendulum 39½ inches, ten-inch swing, sixty beats, strikes the hours, twelve-inch hands, wood rod and two-pound ball. A letter to this firm will secure the name of the nearest jeweler handling their goods.

Sir W. H. Preece, formerly chief electrician to the British post-office, has been engaged for some time on the study of the magnetic influences upon the compass of the Manacle rocks, off the coast of Cornwall, Eng., upon which the steamships *Mohegan* and *Paris* were wrecked, and, as the result of his investigations, he states that if any navigator sets his compass from Cherbourg to the Lizard, without knowing the variations of the magnet that have occurred during the last five or six years, he would run upon the Manacles. The variation is bringing the needle nearer to the north pole, and in ten years it has varied a whole degree. A difference of a degree in a compass signifies an error of one mile in a course of sixty miles.

According to *Electricity*, an experiment designed to have an influence on the horticultural industry was recently made in California, where electricity was used as a pumping agent for irrigation. The experiment was a success in every respect, and it was announced at its conclusion that there would be an immediate extension of the electric wires throughout the whole Berryessa district. The experiment and the success attending it are believed to have solved the water question for orchards, as far as the Santa Clara Valley is concerned.